

CLAIMS

What I claim is:

- 5 1. An apparatus for flushing contaminants from a hydraulic system which includes a master cylinder and at least one component having a bleeder valve, said apparatus comprising:
- a) a holding vessel for old fluid;
- b) a pump coupled to draw the old fluid from said holding
10 vessel; and
- c) a valve having a master cylinder line and at least one bleed valve line both for connection to the hydraulic system to be serviced, said valve coupled to said pump and to said holding
15 vessel for receiving the old fluid from said pump and directing it through the hydraulic system to be serviced and returning it to said holding vessel.
2. An apparatus as claimed in claim 1 wherein said valve has a
20 first position wherein the fluid from said pump is directed through the hydraulic system to be serviced in a first direction and returned to said holding vessel and a second position wherein the fluid is routed through the hydraulic system in an opposite direction and returned to said holding vessel.

3. An apparatus as claimed in claim 1 wherein the hydraulic systems to be serviced have a plurality of components each of which has a bleeder valve, said apparatus further comprising:

a) said valve having a plurality of bleeder valve lines each for connection to a different one of the bleeder valves of the components of the hydraulic system to be serviced; and

b) a plurality of shutoff valves each located in a different one of said plurality of bleeder valve lines, said shutoff valves are individually operable to control the flow of fluid through their respective ones of said bleeder valve lines.

4. An apparatus for flushing, replacing a fluid and bleeding a hydraulic system including a master cylinder and at least one component having a bleeder valve, said apparatus comprising:

a) a holding vessel for old fluid;

b) a supply vessel of new fluid;

c) a fluid selector valve coupled to said holding vessel and to said supply vessel for receiving the old fluid from said holding vessel during system flushing and the new fluid from said supply vessel during system fluid replacement and bleeding;

d) a pump coupled to move the old fluid from said holding vessel through said flow selector valve during system flushing and to move the new fluid from said supply vessel through said fluid selector valve during fluid replacement and bleeding; and

e) a flow reversing valve coupled to said pump and to said holding vessel and having a master cylinder line and at least one bleed valve line both for connection to the hydraulic system to be serviced, said flow reversing valve having a first position wherein the fluid from said pump is directed through the system in a first direction and returned to said holding vessel and a second position wherein the fluid is routed through the hydraulic system in an opposite direction and returned to said holding vessel.

10

5. An apparatus as claimed in claim 4 wherein the hydraulic systems to be serviced have a plurality of components each of which has a bleeder valve, said apparatus further comprising:

a) said flow reversing valve having a plurality of bleeder valve lines each for connection to a different one of the bleeder valves of the components of the hydraulic systems to be serviced; and

b) a plurality of shutoff valves each located in a different one of said plurality of bleeder valve lines, said shutoff valves are individually operable to control the flow of fluid through their respective ones of said bleeder valve lines.

6. An apparatus as claimed in claim 4 wherein the hydraulic systems to be serviced have a plurality of components each having a bleeder valve with at least two of the components in fluid communication with each other, said apparatus further comprising:

5 a) said flow reversing valve having a plurality of bleeder valve lines each for connection to a different one of the bleeder valves of the components of the hydraulic system to be serviced;

 b) a plurality of three-way valves each located in a different one of the plurality of bleeder valve lines of said
10 flow reversing valve, each of said three-way valves having a first port from which the distal end of the bleed valve line extends, a second port from which the proximal end of the bleeder line extends to said flow reversing valve and a third port;

 c) a fluid collecting manifold coupled to the third port of
15 each of said three-way valves;

 d) a fluid return line connected between said fluid collecting manifold and said fluid return manifold to direct fluid to said holding vessel; and

 e) each of said three-way valves have a first position
20 wherein the first and second ports thereof are in fluid communication with each other and the third port is blocked and a second position wherein the first and third ports are in fluid communication with each other and the second port is blocked.

7. An apparatus as claimed in claim 6 wherein each of said three-way valves are individually operable solenoid valves for sequentially directing fluid through the two components which are in fluid communication with each other and returning that fluid to said holding vessel.

8. An apparatus as claimed in claim 6 and further comprising a shutoff valve in said fluid return line for blocking the flow of fluid to said holding vessel.

9. An apparatus as claimed in claim 4 wherein said fluid selecting valve and said flow reversing valve are solenoid actuated valves.

10. An apparatus as claimed in claim 4 wherein said fluid selecting valve and said flow reversing valve are solenoid actuated valves operated by a programmable electronic control unit which actuates said fluid selecting and flow reversing valves between their first and second positions at predetermined intervals.

11. An apparatus as claimed in claim 4 wherein said flow reversing valve is a solenoid actuated valve which is cycled between its first and second positions for reversing the direction of fluid flow during flushing of the hydraulic system being serviced.

12. An apparatus as claimed in claim 4 wherein said pump produces a pulsating output pressure.

13. An apparatus as claimed in claim 4 and further comprising a filter between said flow reversing valve and said holding vessel for removing contaminants from the fluid being returned to said holding vessel during hydraulic system flushing operations.

14. An apparatus as claimed in claim 4 and further comprising a fluid condition sensor for determining the condition of the fluid being returned to said holding vessel during hydraulic system fluid replacement and bleeding operations and providing an indication upon detecting clean fluid.

15. An apparatus as claimed in claim 4 and further comprising:

a) an injection sub-system for injecting a fluid compatible dye into the new fluid supplied to the hydraulic system during fluid replacement and bleeding operations; and

5 b) an optical sensor for determining the clarity of the fluid being returned to said holding vessel during hydraulic system fluid replacement and bleeding operations and providing an indication of the detection of clear fluid.

10 16. An apparatus as claimed in claim 4 and further comprising an ion-selective electrode for detecting metallic ions in the fluid being returned to said holding vessel during hydraulic system fluid replacement and bleeding operations and providing an indication upon detecting the absence of the ions in the
15 returning fluid.

17. An apparatus as claimed in claim 4 and further comprising:

a) a waste fluid vessel having inlet and outlet ports; and

20 b) a normally closed shutoff valve connected between said holding vessel and the inlet port of said waste fluid vessel, said shutoff valve being actuated to an open position upon completion of fluid replacement and bleeding operations to direct the fluid from said holding vessel into said waste fluid vessel.

18. An apparatus as claimed in claim 17 and further comprising a pump connected to the outlet port of said waste fluid vessel for pumping the old fluid from said holding vessel into said waste fluid vessel.

5

19. An apparatus as claimed in claim 4 wherein said supply vessel of new fluid comprises:

a) a housing having an outlet opening and a removable lid with an air inlet port formed in the lid;

10 b) a collapsible bag of new fluid in said housing and having an outlet fitting positioned to extend through the outlet opening of said housing; and

15 c) a residual pressure valve on the distal end of the outlet fitting of said collapsible bag and coupled to said fluid selector valve, said residual pressure valve being normally closed and movable to an open position upon the build-up of a differential pressure across said residual pressure valve.

20. An apparatus as claimed in claim 4 wherein said supply vessel of new fluid comprises:

a) a housing having one end open and an outlet opening in the opposite end;

5 b) an elongated cartridge of new fluid positioned in said housing and extending from the open end thereof and having an outlet fitting extending through the outlet opening of said housing, said cartridge having a piston axially movable toward the outlet fitting thereof for moving the new fluid out of said
10 cartridge;

c) a residual pressure valve on the distal end of the outlet fitting of said cartridge and coupled to said fluid selector valve, said residual pressure valve being normally closed and movable to an open position upon the build-up of a differential
15 pressure across said residual pressure valve; and

d) a ram operable to move the piston of said cartridge.

21. An apparatus as claimed in claim 4 and further comprising:

a) a pressure take-off port coupled to the master cylinder
20 line of said flow reversing valve; and

b) a hand operated nozzle demountably coupled to said pressure take-off port for bench bleeding the master cylinder of the hydraulic system to be serviced when said pump is being rotated in a first direction and said flow reversing valve is in

the first position and for cleaning out the master cylinder when said pump is being rotated in a second direction and said flow reversing valve is in the first position.

- 5 22. An apparatus as claimed in claim 4 and further comprising a vibrator for demountable attachment to the master cylinder and movable to other components of the hydraulic system to be serviced for loosening sludge and corrosion by-products in the system.

10

23. A method for flushing, replacing a hydraulic fluid and bleeding a hydraulic system comprising the steps of:

- 15 a) replacing a cap of a master cylinder of the hydraulic system with an adapter having a master cylinder line extending through said adapter into a reservoir of the master cylinder;
- 20 b) attaching a different bleeder valve line to a bleeder valve of each of a plurality of components of the hydraulic system;
- c) opening the bleeder valves;
- d) energizing a pump to draw a fluid from a holding vessel through a fluid selecting valve and through said pump to a flow reversing valve, said flow reversing valve having a first position wherein the fluid from said pump is supplied to said master cylinder line for movement through the hydraulic system in

a first direction and returned through said bleeder valves lines and said flow reversing valve to said holding vessel, and having a second position wherein the fluid from said pump is supplied to said bleeder valves for movement through the hydraulic system in an opposite direction;

e) actuating said flow reversing valve between the first and second positions thereof for flushing contaminants from the hydraulic system; and

f) actuating said fluid selecting valve to a second position whereby said pump will draw fluid from a supply vessel of new fluid, through said fluid selecting valve, through said pump and through said flow reversing valve into the hydraulic system for replacing the old fluid and bleeding the air out of the hydraulic system.

24. The method of claim 23 comprising the further step of opening a plurality of normally closed shutoff valves one at a time in a predetermined sequence, each of said shutoff valves being located in a different one of said bleeder valve lines.

25. The method of claim 23 comprising the further step of passing the fluid returning to said holding vessel from the hydraulic system through a filter.

26. The method of claim 23 comprising the further step of attaching a vibrator to the master cylinder of the hydraulic system for loosening contaminants in the system.

5 27. The method of claim 26 comprising the further step of moving the vibrator to other components of the hydraulic system.

28. The method of claim 23 comprising the further steps of:

10 a) injecting a fluid compatible dye into the new fluid being supplied to the hydraulic system during fluid replacement and bleeding operations; and

15 b) operating an optical sensor for determining the clarity of the fluid being returned to said holding vessel during hydraulic system fluid replacement and bleeding operations and providing an indication upon detecting clear fluid.

29. The method of claim 23 comprising the further step of operating an ion-selective electrode for detecting metallic ions in the fluid being returned to said holding vessel during
20 hydraulic system fluid replacement and bleeding operations and providing an indication upon detecting the absence of the ions in the returning fluid.

30. The method of claim 23 comprising the further step of directing the fluid returned to said holding vessel into a waste fluid vessel after step(f).

5 31. The method of claim 23 comprising the further step of attaching a hand held nozzle to a pressure takeoff port in the master cylinder line for bench bleeding the master cylinder when the pump is being rotated in a first direction and said flow reversing valve is in the first position and for cleaning out the
10 master cylinder when said pump is being rotated in the opposite direction and said flow reversing valve is in the first position.

32. The method of claim 23 comprising the further step of moving the actuator rod of the master cylinder after step (c) and before
15 step (d) toward the master cylinder approximately an inch to provide a fluid flow path through the master cylinder in an area which would otherwise be stagnant.

33. A method for flushing contaminants from a hydraulic system of a type having a master cylinder and other components, said method comprising the steps of:

5 a)connecting a servicing machine to the hydraulic system for moving a flushing fluid through the system; and

b)attaching a vibrator to the master cylinder to move contaminants in the hydraulic system into suspension within the flushing fluid.

10 34. The method of claim 33 and comprising the additional step of moving the vibrator to the other components of the hydraulic system after step (b).

35. A method for cross-flushing a pair of hydraulic system components that are interconnected so as to be in fluid communication with each other, the method comprising the steps of:

15 a) coupling a first three-way valve to a bleeder valve of the first one of the interconnected system components and a second three-way valve to a bleeder valve of the second one of the interconnected system components;

20 b) opening the bleeder valves of the interconnected system components;

c) energizing a pump to draw fluid from a holding vessel and

supply it to the first three-way valve;

d) actuating the first three-way valve to a position wherein the fluid supplied in step (c) is sequentially directed through the interconnected system components into the second three-way valve; and

e) actuating the second three-way valve to a position wherein the fluid received from the interconnected system components in step (d) is returned to the holding vessel.

36. The method of claim 35 comprising the further step of passing the fluid returning to said holding vessel from the second three-way valve through a filter.